

# BUSBY'S BORE - SYDNEY'S SECOND

## WATER SUPPLY

M.J.Dale \* & P.J.Burgess\*\*

### 1. INTRODUCTION

During the Bicentennial Year it is important to look at some of the early construction which took place during the founding of the City of Sydney. Detailed in this paper is the construction of Sydney's second water supply which later became known as Busby's Bore. Busby's Bore, a 3½ kilometre tunnel is a major feat of construction for a colony only 39 years old. Also examined is the bores effect on the construction of the Eastern Distributor road tunnels. Both imperial and metric units have been given throughout the description of the bore to retain the historical background to the water supply scheme.

### 2. SYDNEY'S SECOND WATER SUPPLY

Sydney's first water supply was the Tank Stream. This stream was polluted by 1820, often flowing with raw sewage. Earl Brisbane in 1823 employed Mr. John Busby, a mineral surveyor from Northumberland (making Busby Sydney's first engineering geologist an observation also made by Branagan, 1985), to investigate the possibility of devising a water supply for Sydney.

Busby arrived in Sydney in early 1824, immediately going to Newcastle to investigate the local coal mining operations and to construct a breakwater on the Hunter River. By 1826 Sydney's water supply was getting very serious. Busby's first proposal was to pump water from the Waterloo Swamps to Hyde Park, the pumps driven by steam engine, waterwheel or convict propelled treadmill. The idea was abandoned, labour was too scarce to waste on the treadmill although considered a powerful deterrent to criminals.

Busby's alternative was to "drive a mine, bore or tunnel" from the Lachlan Swamps (now part of Centennial Park) to a 15 million gallon (68 million litre) reservoir at Hyde Park. The reservoir was later scrapped. The catchment at the Lachlan Swamps was considered to consist of a "great sand sponge carrying water at a depth" varying from 43 to 109 feet (13.1 to 33.2m) with a catchment of approximately 2¼ square miles (583 hectares). This is compared to the limited catchment of the Tank Stream which was only 180 acres (73 hectares).

The bore was commenced on September 1827 using convict labour but took over 10 years to complete having to deviate to avoid water logged "quicksand" and "adhesive pipeclay". The convict labour was generally unskilled, with Busby having to instruct the convicts with the "business of mining". Four-fifths of the tunnel was through solid rock and when it struck sand it had to be lined with masonry hauled from the rock quarries at Pyrmont or

Darlinghurst gaol. Soon after starting the bore Busby was diverted because of a searing drought to constructing six wells in the Barrack Square in George Street and in Market, King, Pitt and Liverpool Streets.

The tunnel work continued and by 1830 was supplying sufficient (34,000 gallons per day - 154,700 litres) drinkable water to the public from "seepage springs" which were intercepted. The tunnel was finally completed in 1837 but even then the Government Surveyors had miscalculated the levels and almost 2950 feet (899m) of the tunnel near Centennial Park was an average 0.3m above true level and the end of the tunnel had to be raised by the 0.3 m to allow the water to gravity feed. The last 70 feet (21.3m) of a tunnel was open cut which was covered with masonry allowing the water to pass from the swamp to the tunnel.

The bore, which runs from Hyde Park to Centennial Park (see Figure 1), is approximately 3380m long and averaged 5 feet (1.52m) high and 4 feet (1.22m) wide and cost £ 22,971.10.9¼ including the salary of the engineers and other expenses. Busby also built 28 vertical shafts (from 6.10 to 24.4m deep) to provide access for the convicts and for the removal of some 255,930 cubic feet (7247m³) of spoil (mainly rock). When the weather was favourable the bore could supply some 300,000 to 400,000 gallons per day (1.37 to 1.82 million litres per day). In 1844 reticulation pipes were laid from the tunnel to about 75 houses in various parts of Sydney. The bore remained the sole source of water until the introduction of the Botany Swamps Scheme in 1859.

### 3. CONSTRUCTION OF THE BORE

Unlike today's expensive tunnel operations Busby did not have a geotechnical investigation to determine the rock types, excavatability and support requirements, standup time etc. but relied on his own judgement. He certainly was not worried by contractual problems. Presumably at the time [1827] he would have been able to stand on the highest topographic point above the tunnel near Victoria Barracks and been able to see much of the natural topography and even many of the sandstone benches between the Lachlan Swamps and Hyde Park.

Busby (as the Superintendent) was stated to have had so much respect for his convict workers, who were excavating the tunnel, that he did all his supervision from the surface; a view not supported by Branagan (pers. comm.). It does appear, however, that John Busby employed his son Alexander to assist with the underground work. It was said by a newspaper writer later in 1903, however, that:

\* Dale, M.J. - Senior Engineering Geologist, Peter J. Burgess & Ass. P/L.

\*\* Burgess, P.J. - Director, Peter J. Burgess & Ass. P/L

Note Prepared from a plan compiled in 1892. This was based on information shown on a lithograph produced by S. T. Leigh in 1868 to illustrate a report on Busby's Bore dated January 4th 1855.

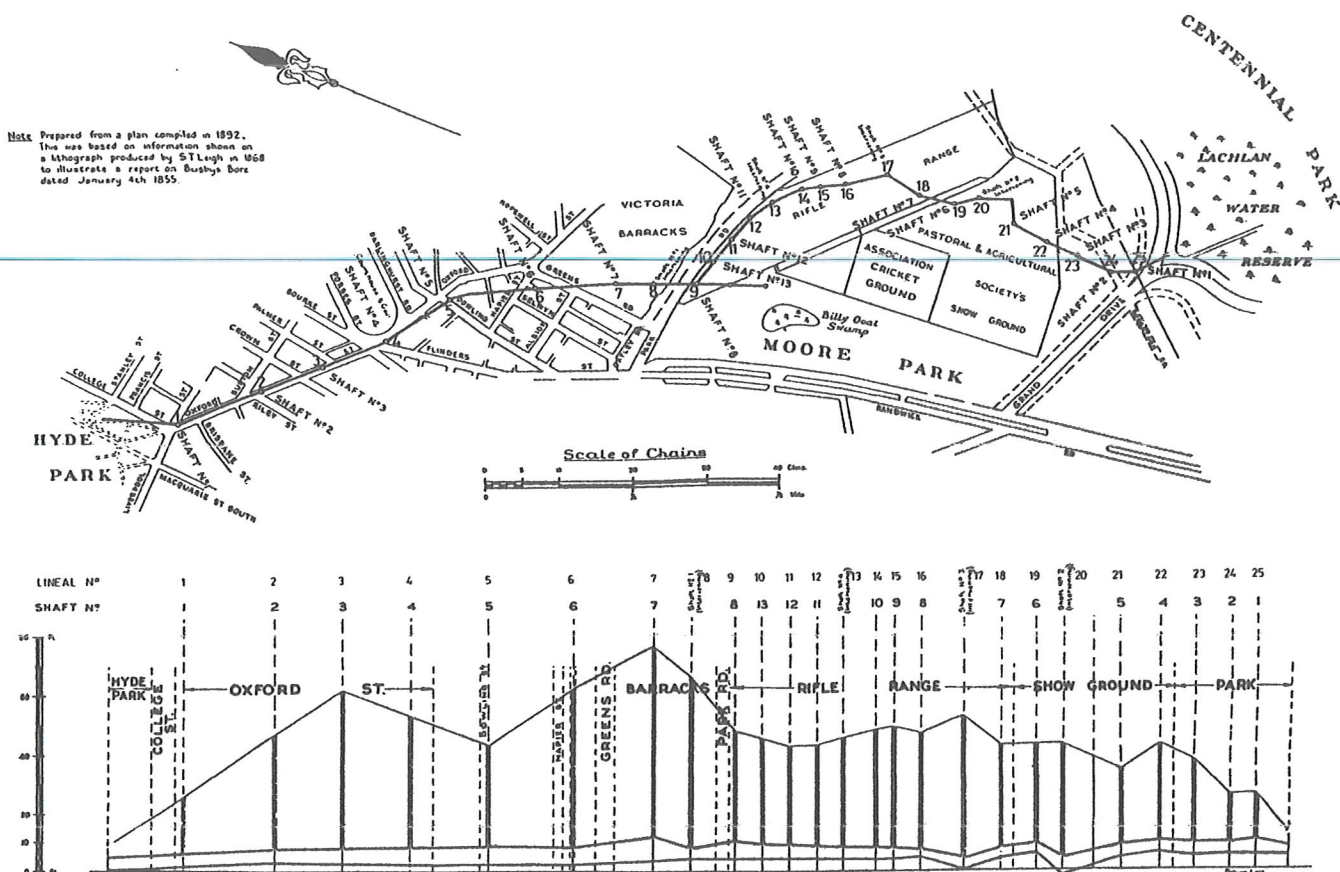


Figure 1. Busby's Bore Plan and Section of Sydney's Second Water Supply

"Mr. Busby's workmen were all gentlemen under permanent engagement to the Government, having been transferred to the Colonial field of labour by the Imperial Government, who were their former employers. These gentlemen were, in the main, most disagreeable. In fact they were so disagreeable that Mr. Busby never cared to go down the Tunnel to direct the work. Instead he had to rely on progressive reports supplied by the less-disagreeable members of his working staff. He could, therefore, only approximately fix the lines of the Tunnel. His instructions were given in the light of information supplied him. Whether the gentlemen below followed his instructions, or the lines of least resistance, does not appear, but the Tunnel zigzags about and rises and dips in an extraordinary way. A fine ten years work. Yet the water came through it all right and it served all requirements up to the installation of the Botany system". (Roseby, 1918).

The following descriptions of tunnelling and conditions during the work are taken from summaries of John Busby's own letters. As already stated the work commenced in September 1827 using convict labour however on the 24th September 1827 Busby wrote to the Colony Secretary asking permission to employ private labour for various parts of the works. It was proposed that a gentleman by the name of Ewing was to sink the first shaft to find the nature of the strata so that Busby could calculate the costs of the tunnel.

The bore started at the centre of Hyde Park with an open cut extending 1570 feet (479m) built up with ashlar covered with stone flag and flagged at the bottom as found necessary.

By November Busby estimated he would require:

- 1400 yards of 9" iron pipe
- 10830 yards of 3" iron pipe
- 6 tons 14 cwt lead (presumably to join the pipes)
- 4000 lbs blasting gunpowder
- 1020 lbs rope yarn
- 6 brass stop cocks for 9" pipes
- 18 brass stop cocks for 3" pipes
- 45 plugs
- 4 miners compasses
- 1 cabinet of mineral tests
- 6 wedgewood retorts
- and stationary

Also in November Busby was allowed to remove the Sandstone blocks from the new gaol at Darlinghurst for use as lining in the tunnel because of the shortage of cutters and masons. By the 26th November 1827 Ewing had sunk the first shaft to 23 feet and proceeded 6 fathoms (11m) inward with the mine. The cost was 20/- (stg) a fathom. By December, 2<sup>3</sup>/<sub>4</sub> fathoms (5m) were being excavated a week. Ewing completed his work in the middle of December.

During December 1827 Busby was also empowered to send convicts who "conducted themselves ill during the week to labour on the treadmill on Saturday" and was thus able "to exercise a very salutary control over them".

In late April 1828 Ewing and others wanted to contract for a further 50 fathoms (91m) of the mine. In response Busby wanted a legal contract to be drawn up for the various workers hired stipulating the mine to be driven not less than 32" (0.81m) wide and average 5'6" (1.68m) high. A quarter of earnings were to be retained until the work was complete.

By June 1828 a prisoner who used to work in copper and coal mines was employed on the water works project rather than at Newcastle. In August 1828 Busby highlighted an "enormous expenditure of gunpowder" which he considered not being misused.

He also set out its use on a specimen of rock composed almost exclusively of fine granulated quartz with minute particles of mica, which was of peculiar hardness and tenacity. Nine mines (or drives) and 2 pits (shafts) are in progress through rocks of different degrees of hardness from the specimen but all are of extreme hardness and except in rare cases not separated by fissures or stratification. For this reason he finds there is no reason to suspect embezzlement of the gunpowder. Also at this time Busby suggests that a private contract be let to cart stones from behind the gaol (Darlinghurst?) and Darling Harbour to cover the tunnel along South Head Road. By December 1828, 98 men were employed 30 of them miners.

Busby wrote to His Excellency Governor Darling in October 1831 to report on the progress of bringing water from the "Lagoons" and gives a summary of the proceedings as he feels "the time which [he] originally stated as being necessary for the completion of the work is likely to be much exceeded". By this stage some 4732 feet (1442m) of tunnelling had been completed. On the positive side Busby found that the iron pipes originally required to separated the lagoon water and water from seepage into the tunnel were unnecessary because the seepage water was of "excellent quality and perfectly free from mineral contamination".

From pit 7 to pit 8 "much labour was required in consequence of the secondary strata" [The Hawkesbury Sandstone below the Ashfield Shale and Mittagong Formation] being chiefly composed of quartz and requiring blasting throughout. Also from pit 4 to pit 5 it was necessary to construct an archway 135 feet (41m) long in consequence of a clay vein which ran nearly parallel with the tunnel [the Oxford Street Dyke].

About 200 feet (61m) west of pit 9 was located a small lagoon [in Moore Park] which kept the pit full of water and "retarded" the connection with pit 8. In concluding Busby wrote that "although much more time had been consumed ..... it will be satisfactory to His Excellency to know that the estimated money expenditure will I trust be fully sufficient". An occurrence rarely seen in the present construction environment.

In July 1832 Busby detailed the progress of the tunnel from October 1831. At this time upwards of 30 yards (27 metres) of the tunnel between Shafts 8 and 9 had to be excavated to finish the "junction of the nine Shafts first commenced". The completion of this section of the bore was delayed by a bed of quick sand about 9 feet (2.7m) wide. The locating of the exact position of the bore was also prevented, the miners having deviated from the line of the tunnel by following a soft seam. This ordinarily would not have slowed the progress but some of the prisoners removed the props supporting the sand before the tunnel could be arched over with stone - the men were punished. The sand kept entering the tunnel from the "crevice" until that closest to the tunnel was "exhausted". At this stage a temporary arch was built to "prevent the clay from coming in on the men at work". This was possibly part of the weathered section of the Great Sydney Dyke.

Continuing the tunnel toward what is now known as Kippax Lake in Moore Park, Busby found that the rock dipped away until there was nothing but sand. This section of the tunnel was "strongly built up", he then struck off the tunnel line at "nearly a right angle" some 100 yards from the face to stay within the sandstone and to avoid the sand.

Further information concerning the construction of the bore between Moore Park Road and the Lachlan Swamps was not available at the time of writing but further information about the bore is available from a survey carried out in 1854 and a clean out of the bore undertaken in 1872.

#### 4. SURVEY AND CLEAN OUT AFTER CONSTRUCTION

During December 1854 and January 1855 the Superintendent of Water Works, John Warner inspected the bore at the order of the City Commissioners. Warner commenced with Shaft No.1 (Pump at Riley Street) with several labourers employed to bucket and lift the debris from the shaft. The tunnel is all built [open cut?] from the terminus in Hyde Park to 50 yards (45.7m) west of Riley Street and from this point to the shaft [No.3] just west of Palmer Street the tunnel is excavated in "hard blue slaty clay". A few feet east of this shaft the sandstone was encountered. The Court House Shaft [No.4] is sunk through 20 feet of clay then 40 feet of hard sandstone.

From Shaft 3 he proceeded to Shaft 5 (the Toll-Bar Shaft on South Head Road) finding that the bottom of the bore was "level as a footpath" which was generally covered with silt over his ankles. He also found that a "very deep and dangerous hole" (>12 feet deep) between Shafts 1 and 2 was also "entirely filled up since 1849".

South of the Darlinghurst Court House, between Shaft No.2 and 3 [5 & 6] Warner found 3 "narrow guts" which were walled with masonry and flagged overhead and varied in length from 20 to 40 feet (6 to 12m); "one narrow pass so low roofed that we found we could get through only by dipping our heads in the water ... unfortunately the water entered our lanterns, we were in darkness, I was reluctantly compelled to retrograde". The Superintendent spoke highly of the conduct of the men employed and they receive a small addition to their wages for their trouble. This part of the tunnel was through "hard sandstone" and was "very rough excavation indeed the height of the roof varying from 4 to 10 feet (1.22 to 3.05m) and the width from 1'10" to 3'6" (0.56 to 1.1m).

South of the Hospital Shaft [No.7] Warner again found the roof dip below the water level near Shaft No.8. The rock was "Fine hard sandstone - striking fire at the blow of a pick". The tunnelling "a rougher piece of tunnelling can be scarcely imagined, it looks as if done in haste. The sides are left blasted, sharp angles are common ...". The tunnel from the Hospital Shaft [Barrack-No.7] toward Sydney "is a noble piece of work. The roof is very seldom less ... than 8 feet high. The walls and floor are rough - no mark of pick work except for a few yards".

East of the Shaft under the quarry at the rear of the Military Barracks [No.9], there are 3 built tunnels (45, 25 and 14 links in length - totalling 16.9m), on the northern end "1836" is chiselled in the key stone. The exact location of these tunnels is not clear but they could equate to the area where Busby had the problems with the crevice of quick-sand.

When the bore was cleaned out in 1872 it was found that there were 6 "blind" or exploratory drives and that the measured length underground was 11088 feet (3380m) compared to the 10032 feet (3058m) surface distance. The first of these blind drives is south of Moore Park Road and is 8 chains (160m) long toward Kippax Lake; the second is between Shaft Nos. 14 & 15 and is 70 links long (14m) the end being walled up; the third starts at the bottom of Shaft No. 17 and is 4 chains (80m) long; the fourth between Shafts No. 18 and 19 which is 48 links long (9.7m) with a branch drive running north for 26 links (5.2m); the fifth is between Shafts 19 & 20 and is 126 links (25m) and the sixth is between Shafts 22 & 23 and runs for 175 links (35m). All these drives run to the South-west.

There were also 9 stone culverts built within the tunnel totalling 681 feet (207m), these culverts were evidently built where the rock was soft and faulty, for the purpose of strengthening the tunnel against the surrounding pressure. In several places under South Head Road the culverts had to be strengthened by cast iron segmental arches and at other places shored up with hardwood. The tunnel over its entire length varied from 3 feet in height and width (0.9 x 0.9m) to large caverns with the roof 10 to 11 feet (3.05 x 3.35m) in height. During the clean out between April and October 1872, 1473 dray loads of sand, muck and stone (mostly the former) were taken out of the tunnel.

#### 5. EASTERN DISTRIBUTOR - ROAD TUNNELS

A major concern to the location and geotechnics of the Eastern Distributor is Busby's Bore. In the Stage 2 Tunnel which is the southbound tunnel the bore is approximately 8 m above the crown of the tunnel (P.J.B., 1987a). This complicates the hydrogeological conditions in this area in that it may be a major seepage source into the road tunnel if there are connecting joints. This may be exacerbated by the occurrence of a narrow dyke which may intersect the road tunnel near Taylor Square. This dyke, known as the Oxford Street Dyke is probably a continuation of the dyke struck in Busby's Bore between shafts No. 4 and 5.

The possibility of an interconnection between the bore and the tunnel is a serious problem considering the amount of water that could flow from the bore. Some consideration has been given to constructing bulkheads in the bore and keeping the water level down by pumps during the Stage 2 Tunnel construction. The level of water in Busby's Bore (as measured in late 1985) is at R.L. 34m AHD (approximately) measured in Shafts Nos. 3 and 4.

The route of the Stage 3 tunnel was initially to intersect Busby's Bore just west of Taylor Square. Again the original proposal was to bulkhead the bore or to fill the bore on either side of the road tunnel with concrete prior to excavation. Heritage issues prevented this alignment and after further site investigation (P.J.B., 1987b) it was decided to route the Stage 3 tunnel over the bore using more expensive and disruptive cut and cover techniques.

#### 6. CONCLUSIONS

Having completed his work Busby retired at the age of 72 with a gratuity of £1000 and a grant of 2000 acres at Kirketon on the Hunter River between Braxton and Singleton. He lived and farmed at Kirketon and died on the 10th May 1857 at the age of 92.

At the time of writing this paper Busby's Bore, which was subject to an Interim Conservation Order and classified and listed by the National Trust, was placed under a permanent conservation order within the Heritage Act.

#### 7. ACKNOWLEDGEMENTS

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